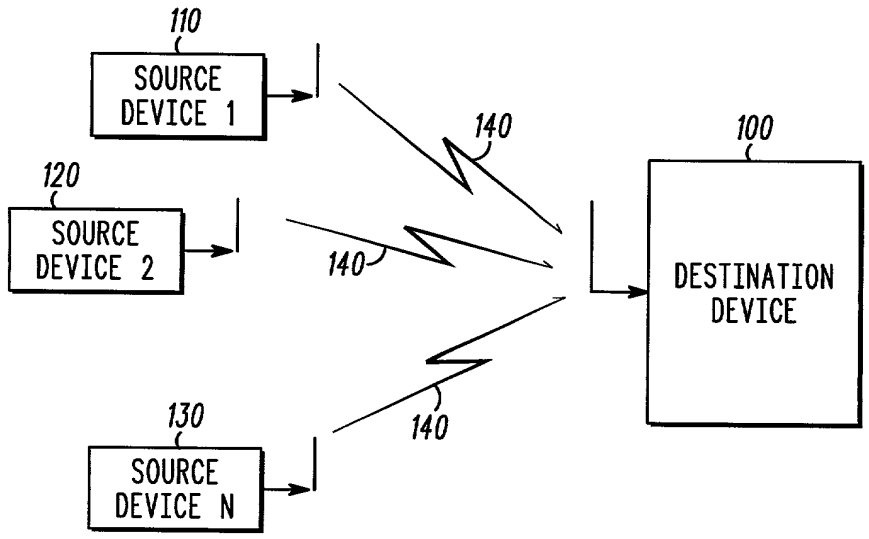

110
SOURCE DEVICE 1
120
SOURCE DEVICE 2
130
SOURCE DEVICE N
140
140
140
100
DESTINATION DEVICE

FIG. 1

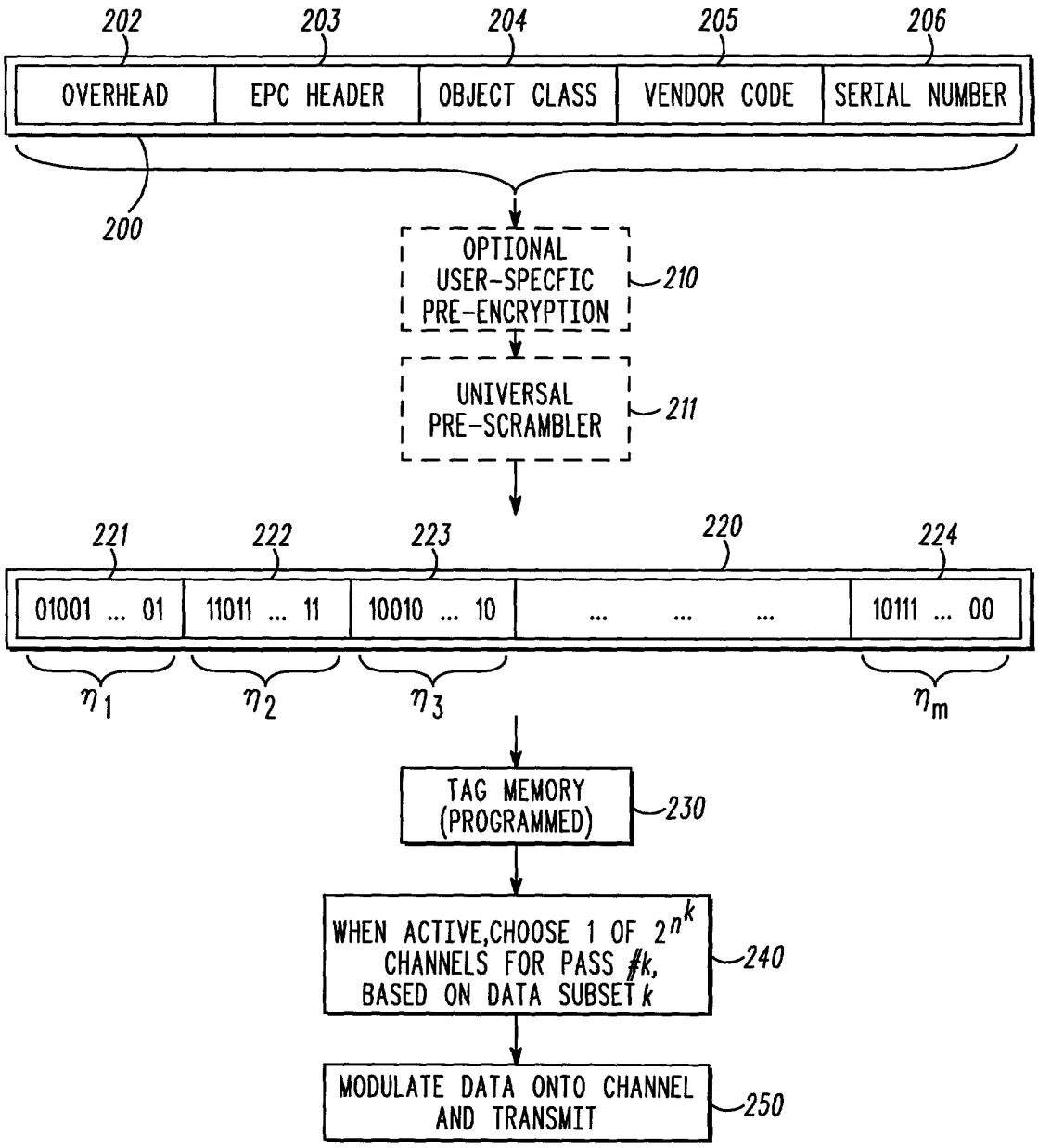

202
203
204
205
206
OVERHEAD
EPC HEADER
OBJECT CLASS
VENDOR CODE
SERIAL NUMBER
200
OPTIONAL USER-SPECFIC PRE-ENCRYPTION
210
UNIVERSAL PRE-SCRAMBLER
211
221
222
223
220
224
01001 ... 01
11011 ... 11
10010 ... 10
... ...
10111 ... 00
η_1
η_2
η_3
η_m
TAG MEMORY (PROGRAMMED)
230
WHEN ACTIVE,CHOOSE 1 OF 2^{n^k} CHANNELS FOR PASS #k, BASED ON DATA SUBSET k
240
MODULATE DATA ONTO CHANNEL AND TRANSMIT
250

FIG. 2

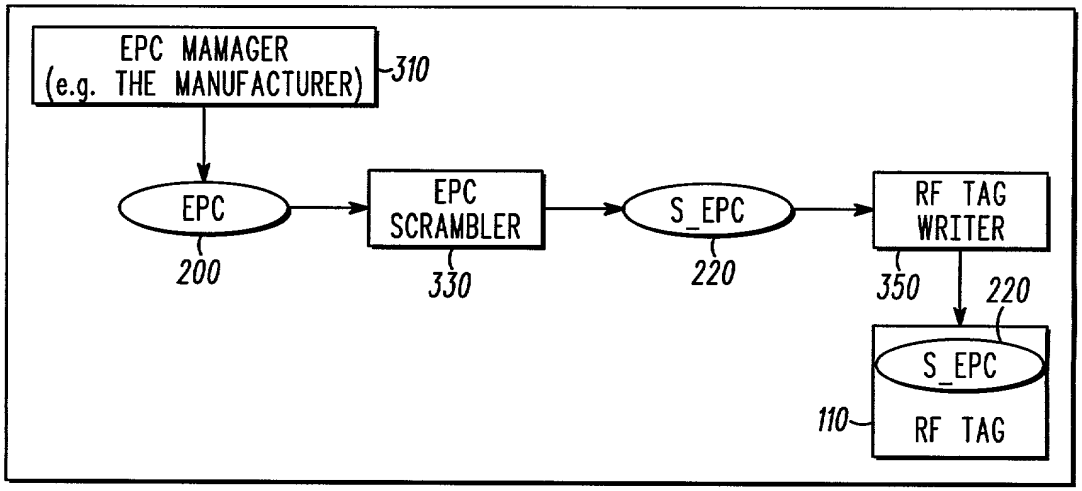

EPC MAMAGER
(e.g. THE MANUFACTURER)
310
EPC
200
EPC
SCRAMBLER
330
S_EPC
220
RF TAG
WRITER
350
220
S_EPC
RF TAG
110

FIG. 3

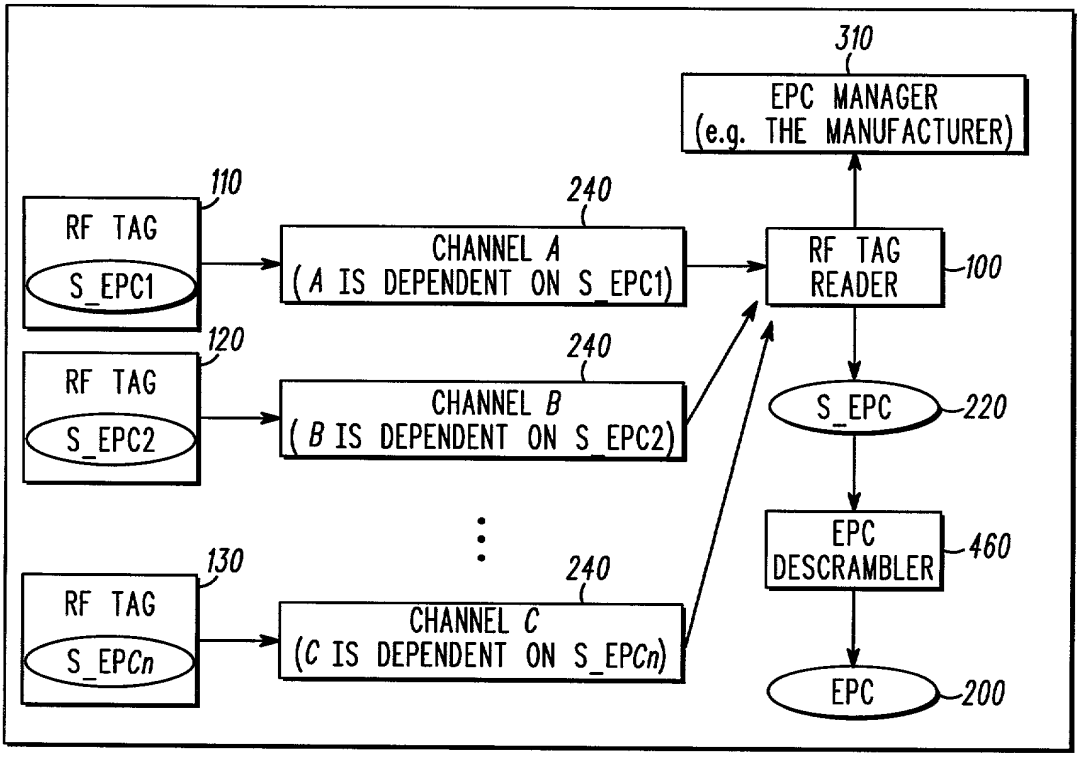

310
EPC MANAGER
(e.g. THE MANUFACTURER)
110
RF TAG
S_EPC1
240
CHANNEL A
(A IS DEPENDENT ON S_EPC1)
RF TAG
READER
100
120
RF TAG
S_EPC2
240
CHANNEL B
(B IS DEPENDENT ON S_EPC2)
S_EPC
220
EPC
DESCRAMBLER
460
130
RF TAG
S_EPCn
240
CHANNEL C
(C IS DEPENDENT ON S_EPCn)
EPC
200

FIG. 4

510

```
SCRAMBLE (DATA, LENGTH) {
  IF (LENGTH == 1)
    RETURN (Sbox [DATA] ) ;
  DATA. LEFT = SCRAMBLE (DATA. LEFT, LENGTH/2) ;
  DATA. RIGHT ^= DATA LEFT ;
  DATA. RIGHT = SCRAMBLE (DATA. RIGHT, LENGTH/2) ;
  DATA. LEFT ^=DATA. RIGHT ;
}
```

520

```
DESCRAMBLE (DATA, LENGTH) {
  IF (LENGTH == 1)
    RETURN (INVERSESbox [DATA] ) ;
  DATA. LEFT ^=DATA. RIGHT ;
  DATA. RIGHT = DESCRAMBLE (DATA. RIGHT, LENGTH/2) ;
  DATA. RIGHT ^= DATA. LEFT ;
  DATA. LEFT = DESCRAMBLE (DATA. LEFT, LENGTH/2) ;
}
```

FIG. 5

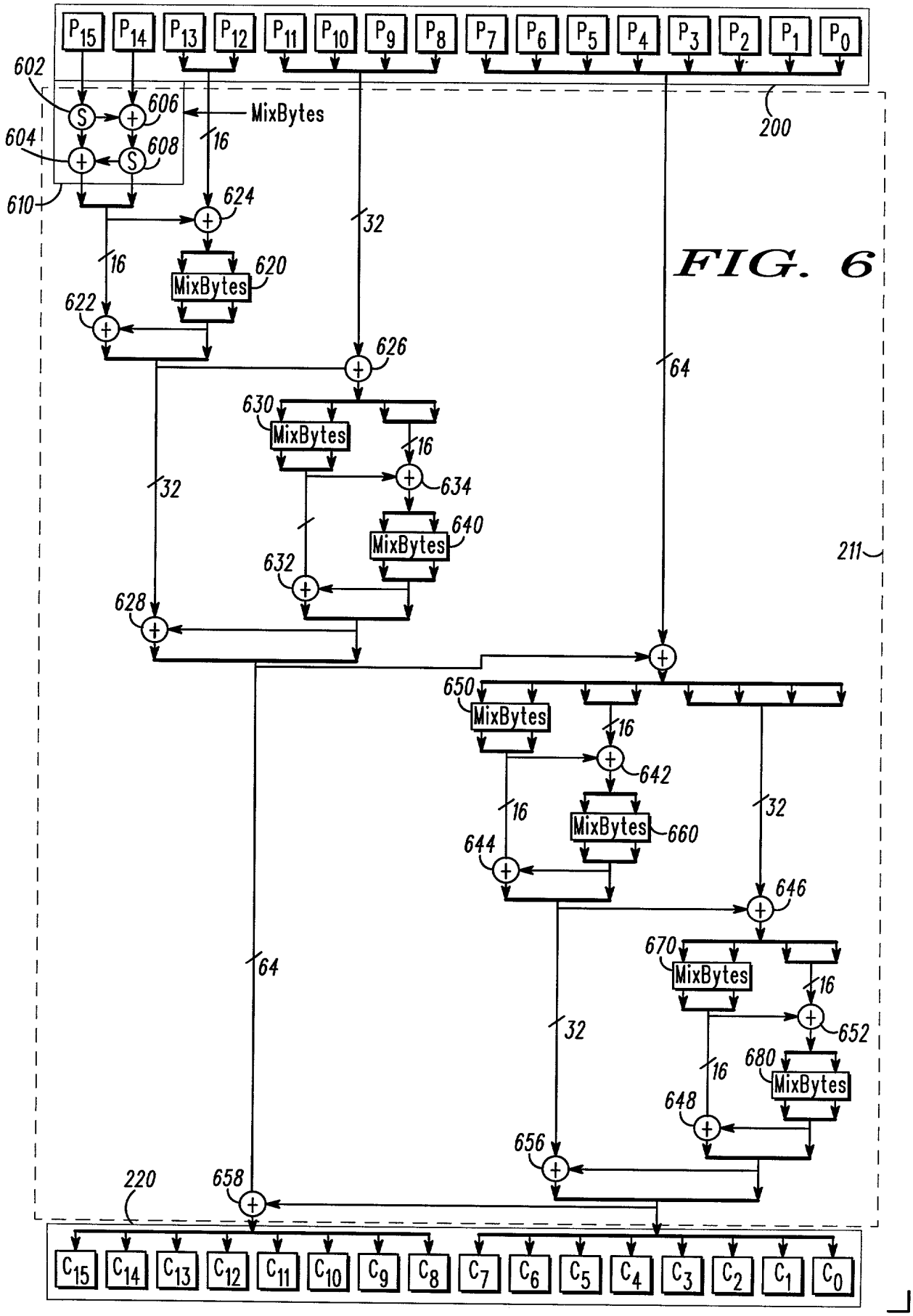


FIG. 6

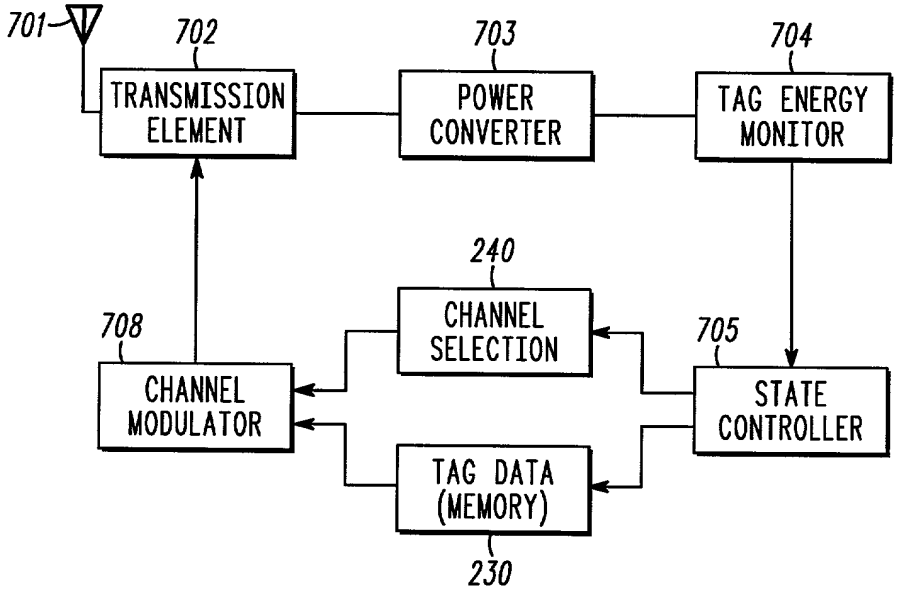

701
702
TRANSMISSION ELEMENT
703
POWER CONVERTER
704
TAG ENERGY MONITOR
240
CHANNEL SELECTION
708
CHANNEL MODULATOR
705
STATE CONTROLLER
TAG DATA (MEMORY)
230

FIG. 7

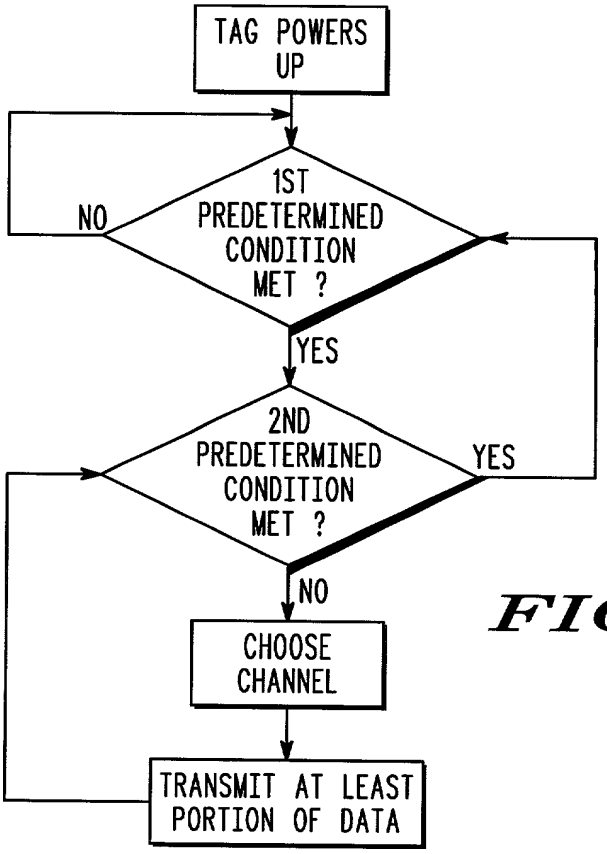

TAG POWERS UP
1ST PREDETERMINED CONDITION MET ?
NO
YES
2ND PREDETERMINED CONDITION MET ?
YES
NO
CHOOSE CHANNEL
TRANSMIT AT LEAST PORTION OF DATA

FIG. 8

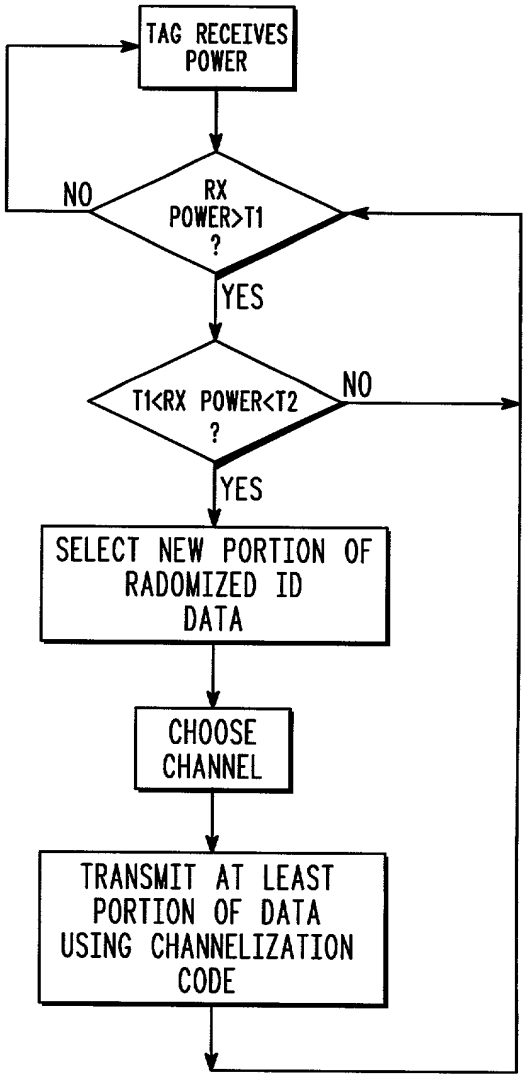

TAG RECEIVES POWER
RX POWER>T1 ?
NO
YES
T1<RX POWER<T2 ?
NO
YES
SELECT NEW PORTION OF RADOMIZED ID DATA
CHOOSE CHANNEL
TRANSMIT AT LEAST PORTION OF DATA USING CHANNELIZATION CODE

FIG. 9

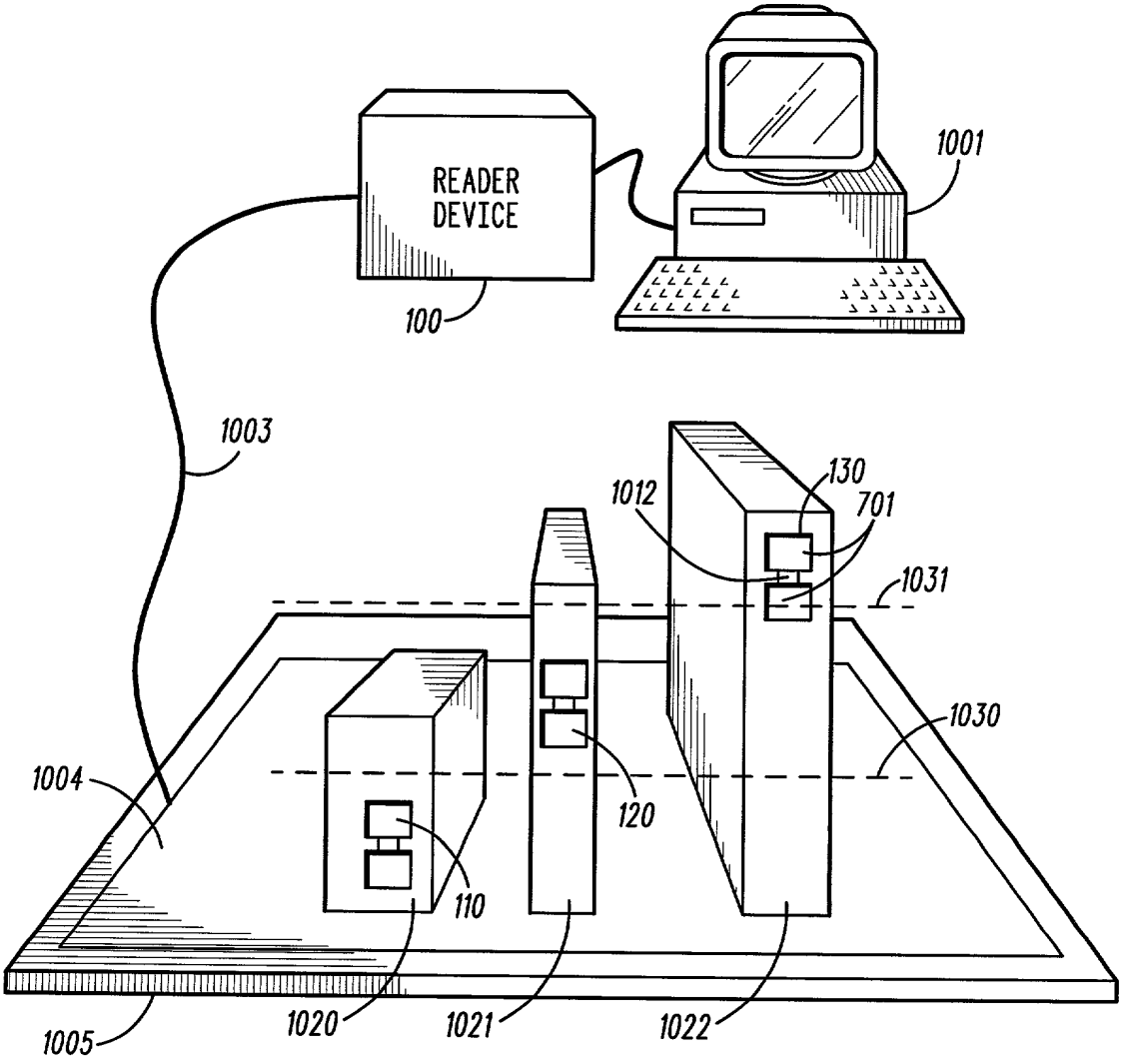
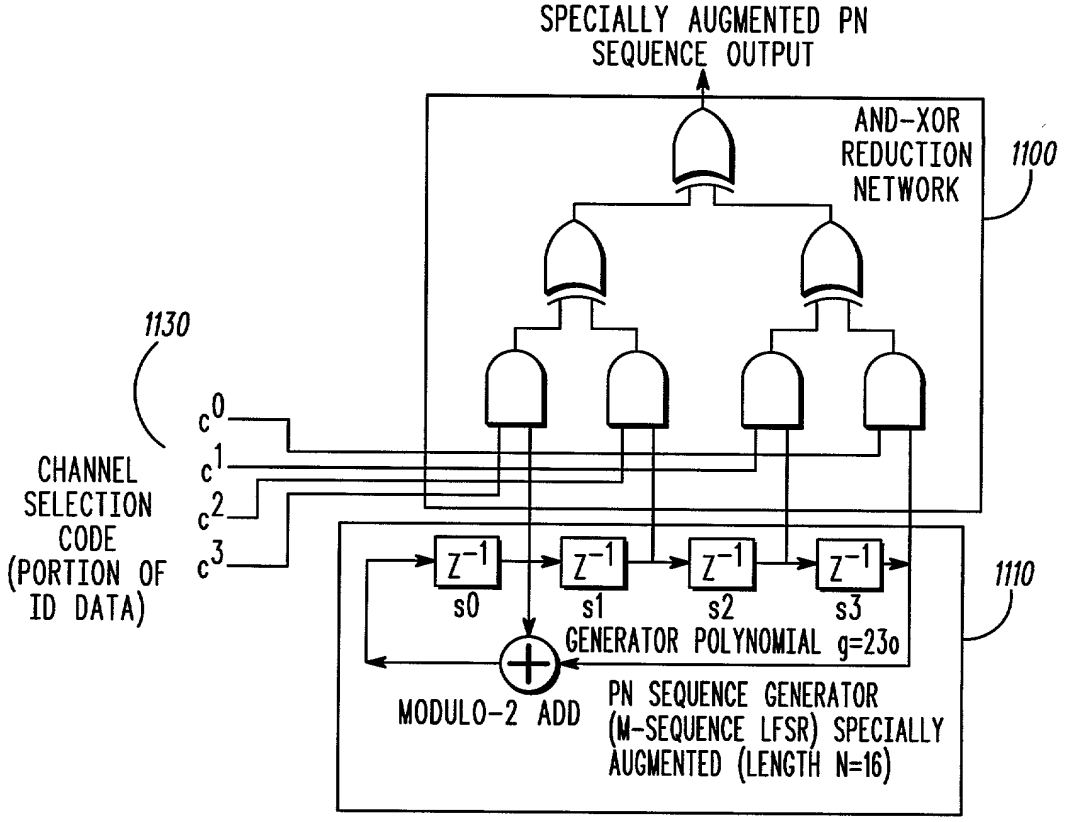

READER
DEVICE
100
1001
1003
1004
1005
1012
130
701
1031
1030
120
110
1020
1021
1022

FIG. 10



1120

LFSR STATE TABLE

CLOCK CYCLE	s0	s1	s2	s3	DEC. STATE
0 (ZERO OUT)	1	1	1	1	15
1 (HELD)	1	1	1	1	15
2	0	1	1	1	7
3	1	0	1	1	11
4	0	1	0	1	5
5	1	0	1	0	10
6	1	1	0	1	13
7	0	1	1	0	6
8	0	0	1	1	3
9	1	0	0	1	9
10	0	1	0	0	4
11	0	0	1	0	2
12	0	0	0	1	1
13	1	0	0	0	8
14	1	1	0	0	12
15	1	1	1	0	14

FIG. 11

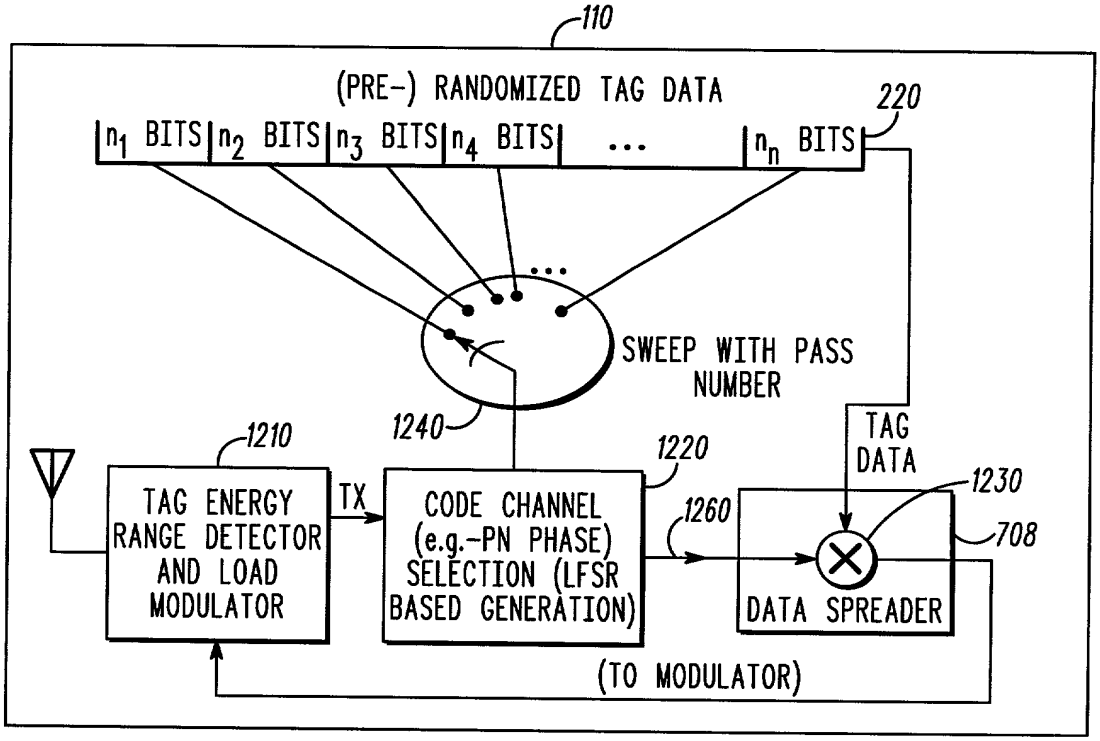

110
(PRE-) RANDOMIZED TAG DATA
220
n_1 BITS
n_2 BITS
n_3 BITS
n_4 BITS
...
n_n BITS
SWEEP WITH PASS NUMBER
1240
1210
TAG ENERGY RANGE DETECTOR AND LOAD MODULATOR
TX
1220
CODE CHANNEL (e.g.-PN PHASE) SELECTION (LFSR BASED GENERATION)
1260
TAG DATA
1230
708
DATA SPREADER
(TO MODULATOR)

FIG. 12

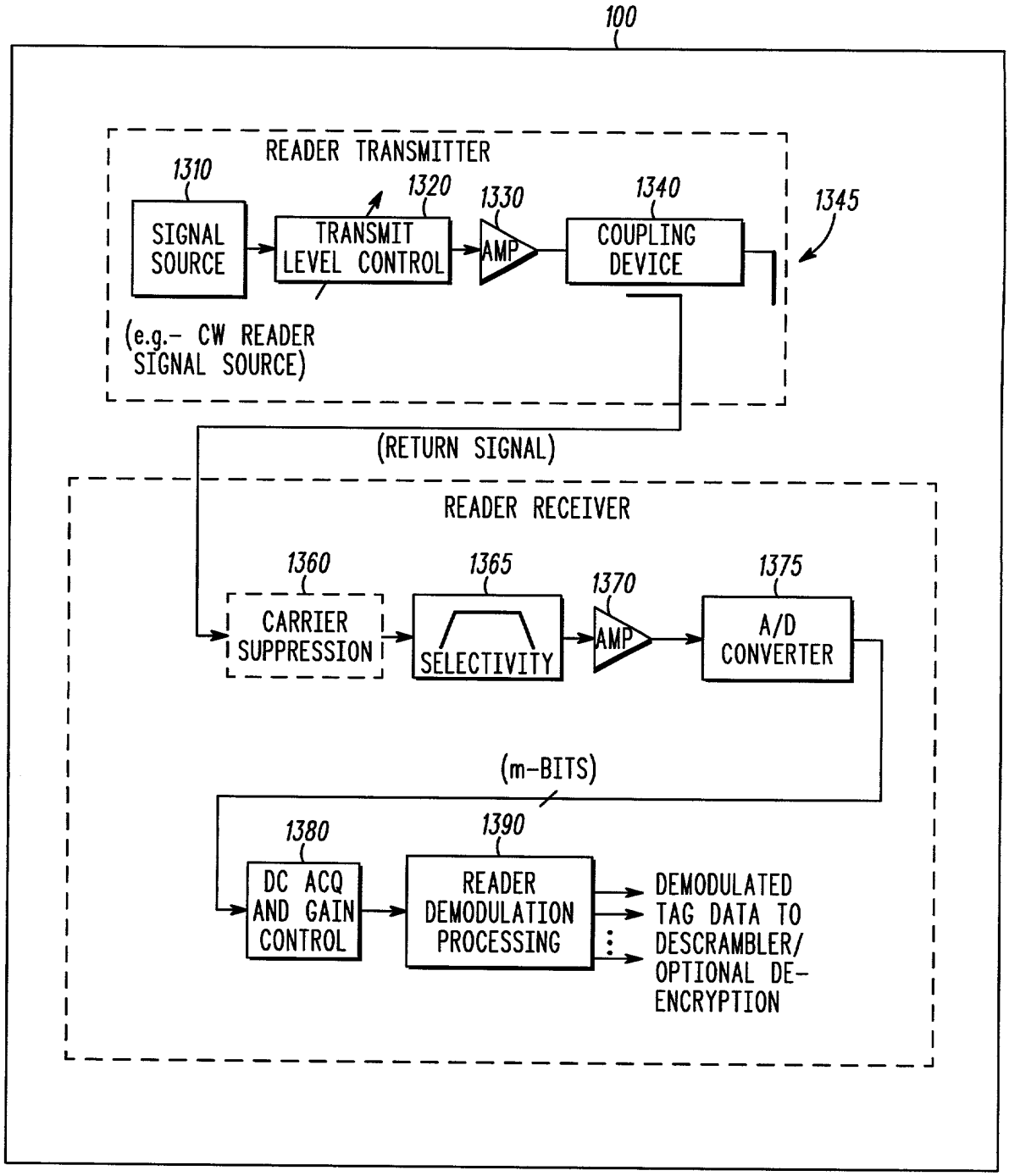
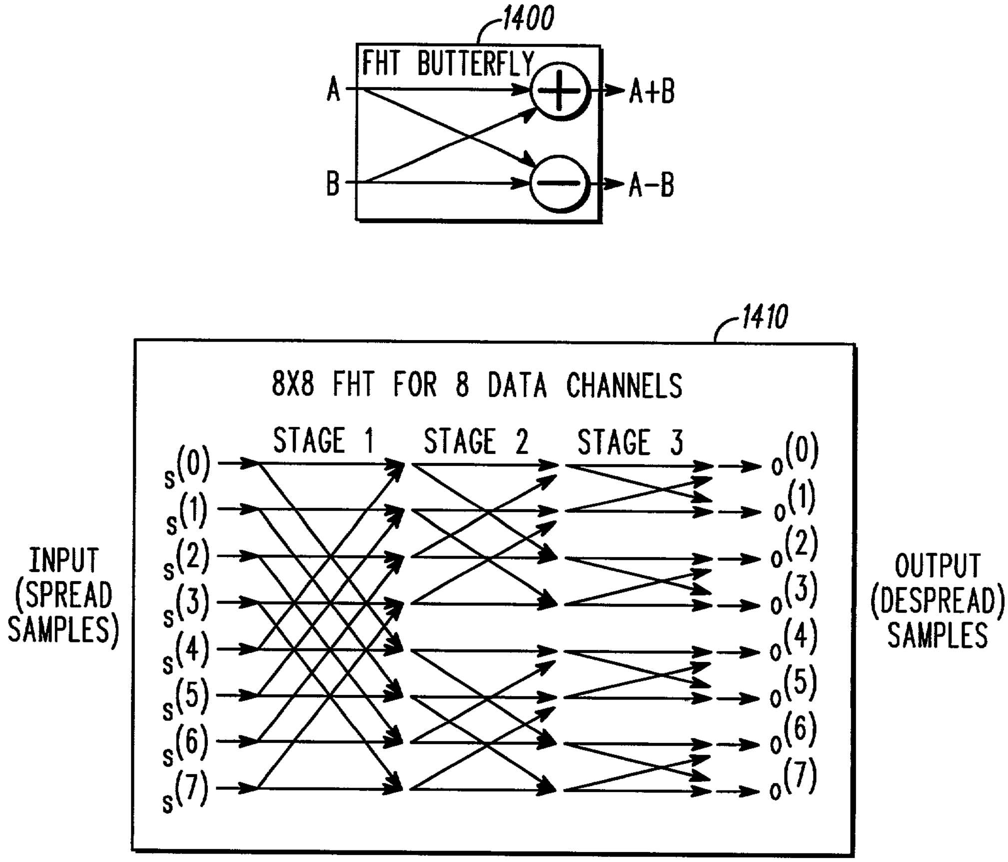

100
READER TRANSMITTER
1310
SIGNAL SOURCE
1320
TRANSMIT LEVEL CONTROL
1330
AMP
1340
COUPLING DEVICE
1345
(e.g.- CW READER SIGNAL SOURCE)
(RETURN SIGNAL)
READER RECEIVER
1360
CARRIER SUPPRESSION
1365
SELECTIVITY
1370
AMP
1375
A/D CONVERTER
(m-BITS)
1380
DC ACQ AND GAIN CONTROL
1390
READER DEMODULATION PROCESSING
DEMODULATED TAG DATA TO DESCRAMBLER/ OPTIONAL DE-ENCRYPTION

FIG. 13



1420

WALSH CODE (0)= 0 0 0 0 0 0 0 0
WALSH CODE (1)= 0 1 0 1 0 1 0 1
WALSH CODE (2)= 0 0 1 1 0 0 1 1
WALSH CODE (3)= 0 1 1 0 0 1 1 0
WALSH CODE (4)= 0 0 0 0 1 1 1 1
WALSH CODE (5)= 0 1 0 1 1 0 1 0
WALSH CODE (6)= 0 0 1 1 1 1 0 0
WALSH CODE (7)= 0 1 1 0 1 0 0 1

8 WALSH CODES (e.g., ROWS OF H_3 HADAMARD MATRIX)

$$(H_{n+1}=\begin{bmatrix} H_n & H_n \\ H_n & \overline{H_n} \end{bmatrix},\ H_0 = 0)$$

FIG. 14

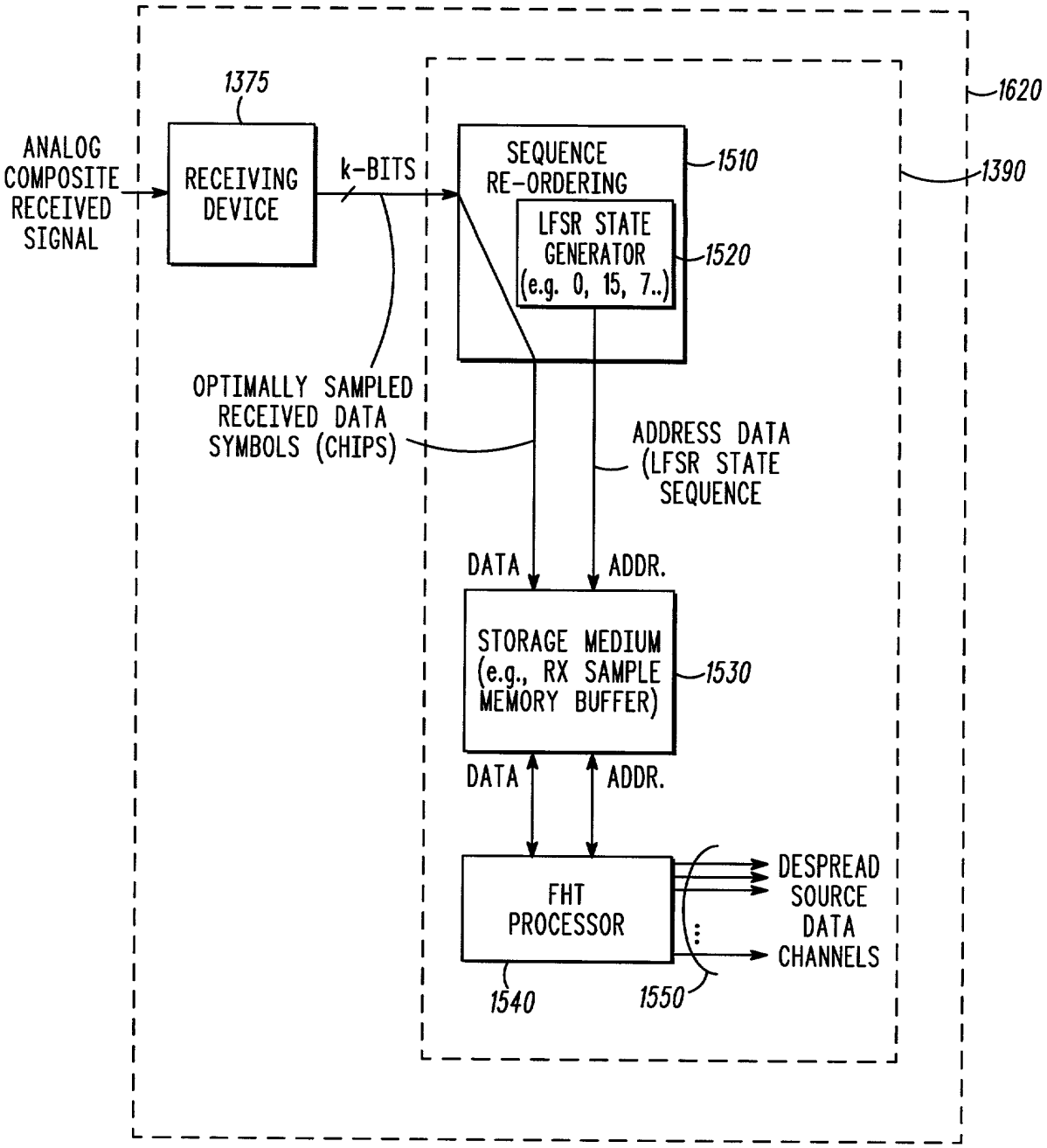

1375
ANALOG COMPOSITE RECEIVED SIGNAL
RECEIVING DEVICE
k-BITS
SEQUENCE RE-ORDERING
1510
LFSR STATE GENERATOR (e.g. 0, 15, 7..)
1520
1620
1390
OPTIMALLY SAMPLED RECEIVED DATA SYMBOLS (CHIPS)
ADDRESS DATA (LFSR STATE SEQUENCE
DATA
ADDR.
STORAGE MEDIUM (e.g., RX SAMPLE MEMORY BUFFER)
1530
DATA
ADDR.
FHT PROCESSOR
DESPREAD SOURCE DATA CHANNELS
1540
1550

FIG. 15

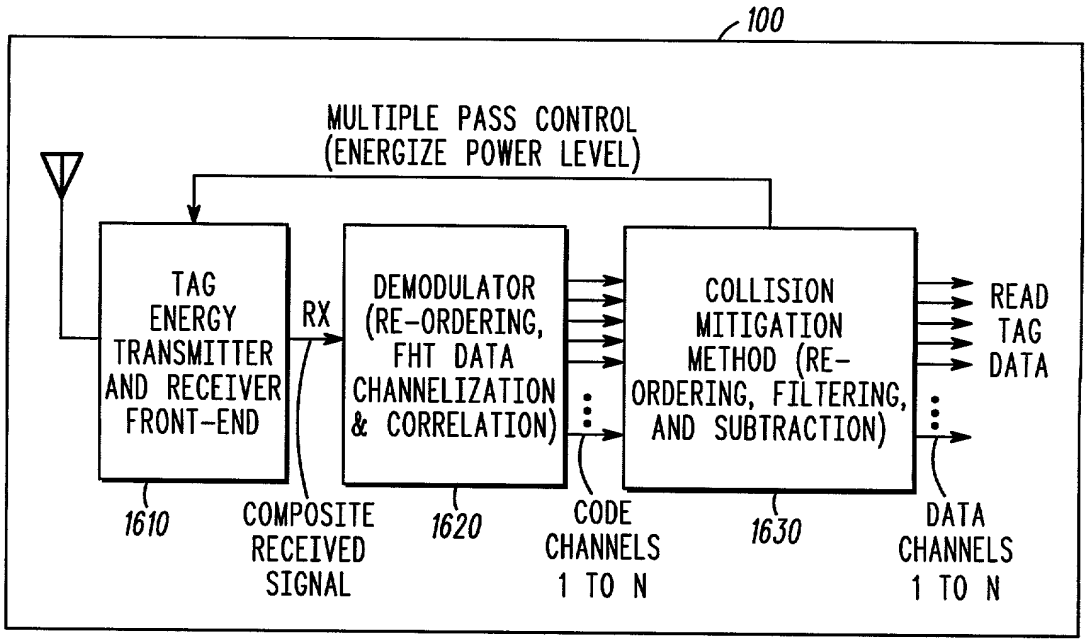
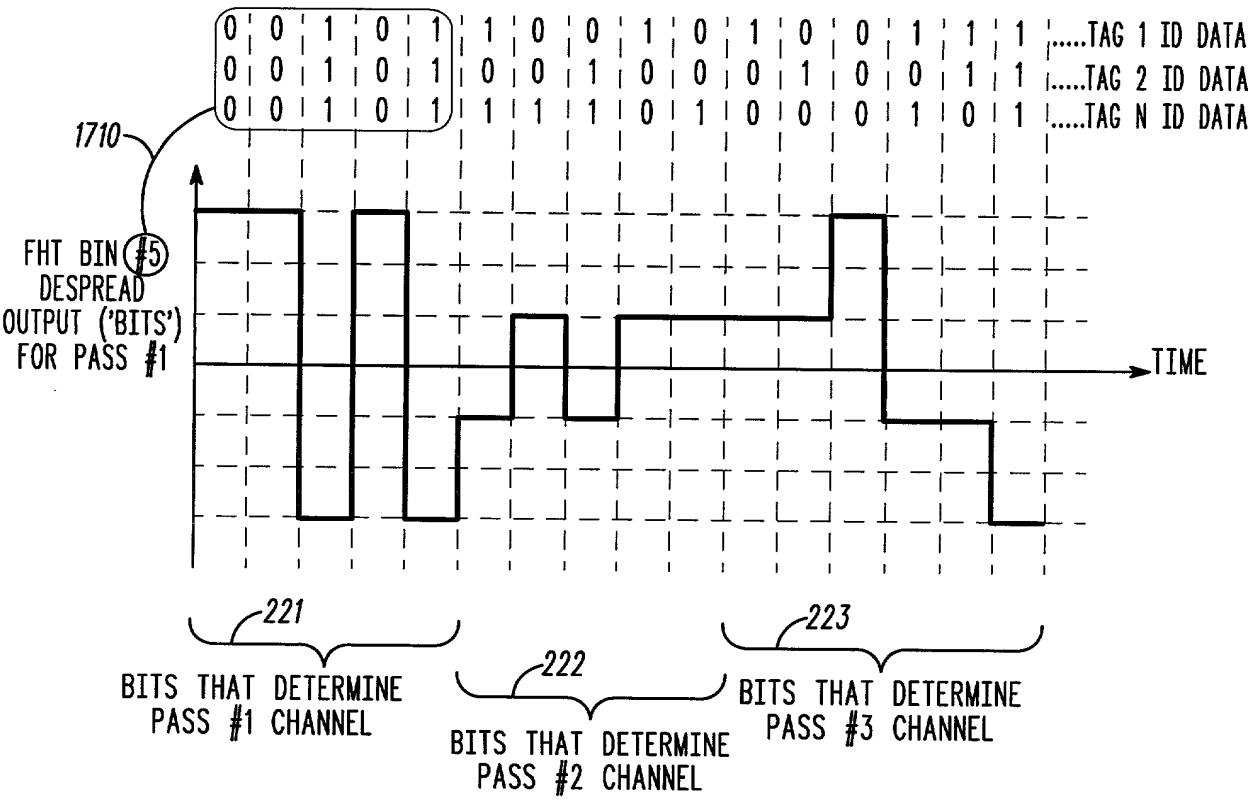

100
MULTIPLE PASS CONTROL
(ENERGIZE POWER LEVEL)
TAG
ENERGY
TRANSMITTER
AND RECEIVER
FRONT-END
RX
DEMODULATOR
(RE-ORDERING,
FHT DATA
CHANNELIZATION
& CORRELATION)
COLLISION
MITIGATION
METHOD (RE-
ORDERING, FILTERING,
AND SUBTRACTION)
READ
TAG
DATA
1610
COMPOSITE
RECEIVED
SIGNAL
1620
CODE
CHANNELS
1 TO N
1630
DATA
CHANNELS
1 TO N

FIG. 16

FIG. 17


0 0 1 0 1 1 0 0 1 0 1 0 0 1 1 1 .....TAG 1 ID DATA
0 0 1 0 1 0 0 1 0 0 0 1 0 0 1 1 .....TAG 2 ID DATA
0 0 1 0 1 1 1 1 0 1 0 0 0 1 0 1 .....TAG N ID DATA
1710
FHT BIN #5
DESPREAD
OUTPUT ('BITS')
FOR PASS #1
TIME
221
BITS THAT DETERMINE
PASS #1 CHANNEL
222
BITS THAT DETERMINE
PASS #2 CHANNEL
223
BITS THAT DETERMINE
PASS #3 CHANNEL

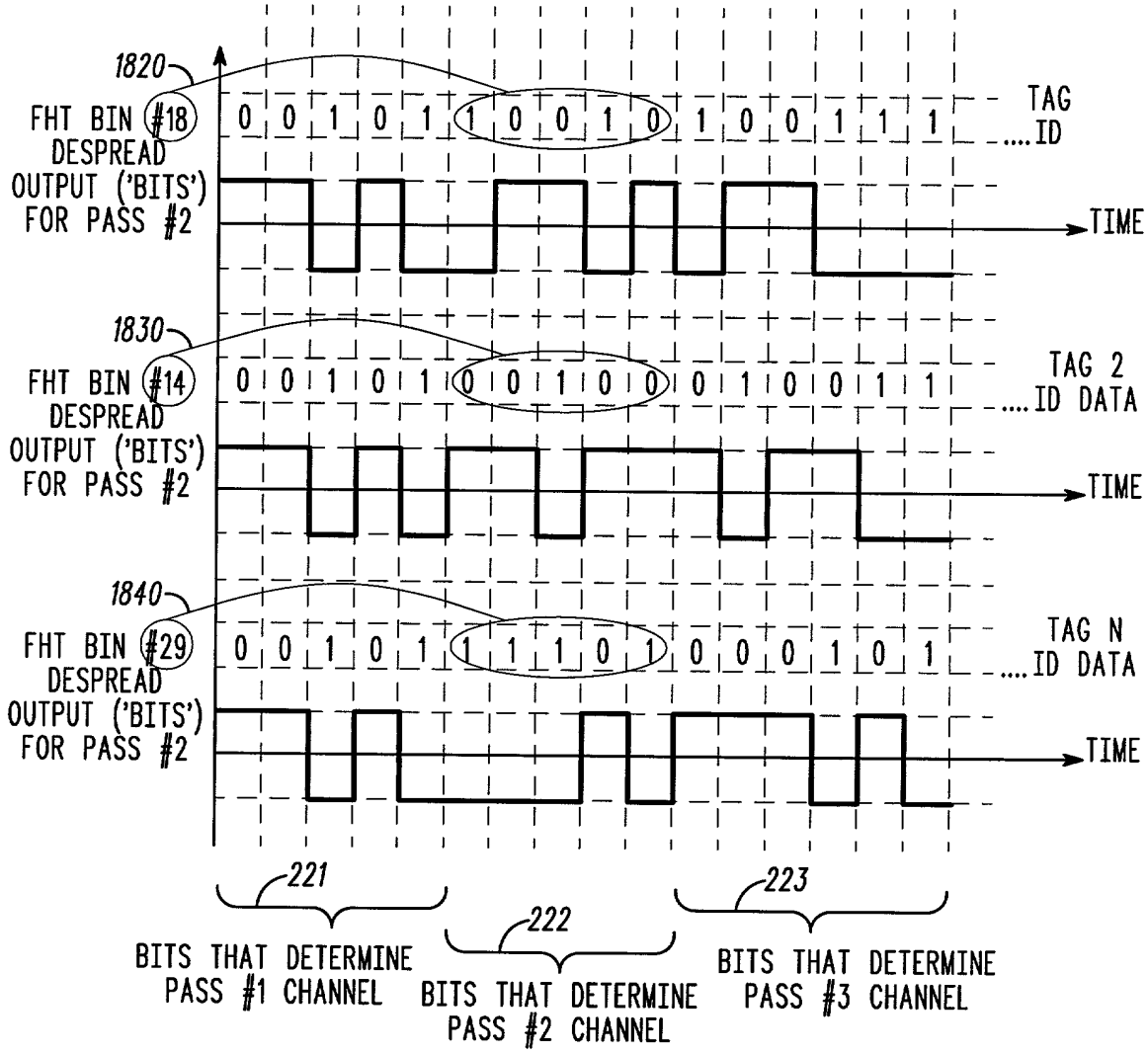

1820
FHT BIN #18
DESPREAD
OUTPUT ('BITS')
FOR PASS #2
0 0 1 0 1 1 0 0 1 0 1 0 0 1 1 1
TAG
....ID
TIME
1830
FHT BIN #14
DESPREAD
OUTPUT ('BITS')
FOR PASS #2
0 0 1 0 1 0 0 1 0 0 0 1 0 0 1 1
TAG 2
....ID DATA
TIME
1840
FHT BIN #29
DESPREAD
OUTPUT ('BITS')
FOR PASS #2
0 0 1 0 1 1 1 1 0 1 0 0 0 1 0 1
TAG N
....ID DATA
TIME
221
BITS THAT DETERMINE
PASS #1 CHANNEL
222
BITS THAT DETERMINE
PASS #2 CHANNEL
223
BITS THAT DETERMINE
PASS #3 CHANNEL

FIG. 18

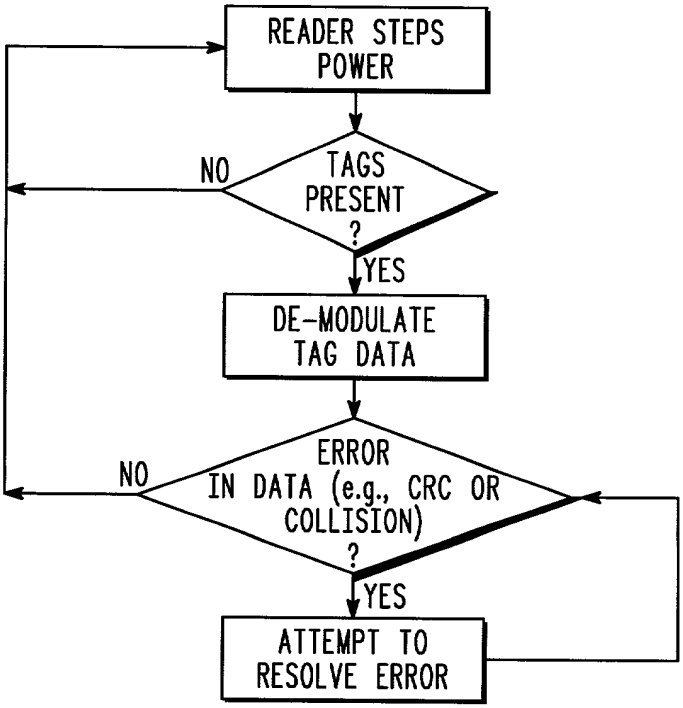

READER STEPS POWER
TAGS PRESENT ?
NO
YES
DE-MODULATE TAG DATA
ERROR IN DATA (e.g., CRC OR COLLISION) ?
NO
YES
ATTEMPT TO RESOLVE ERROR

FIG. 19

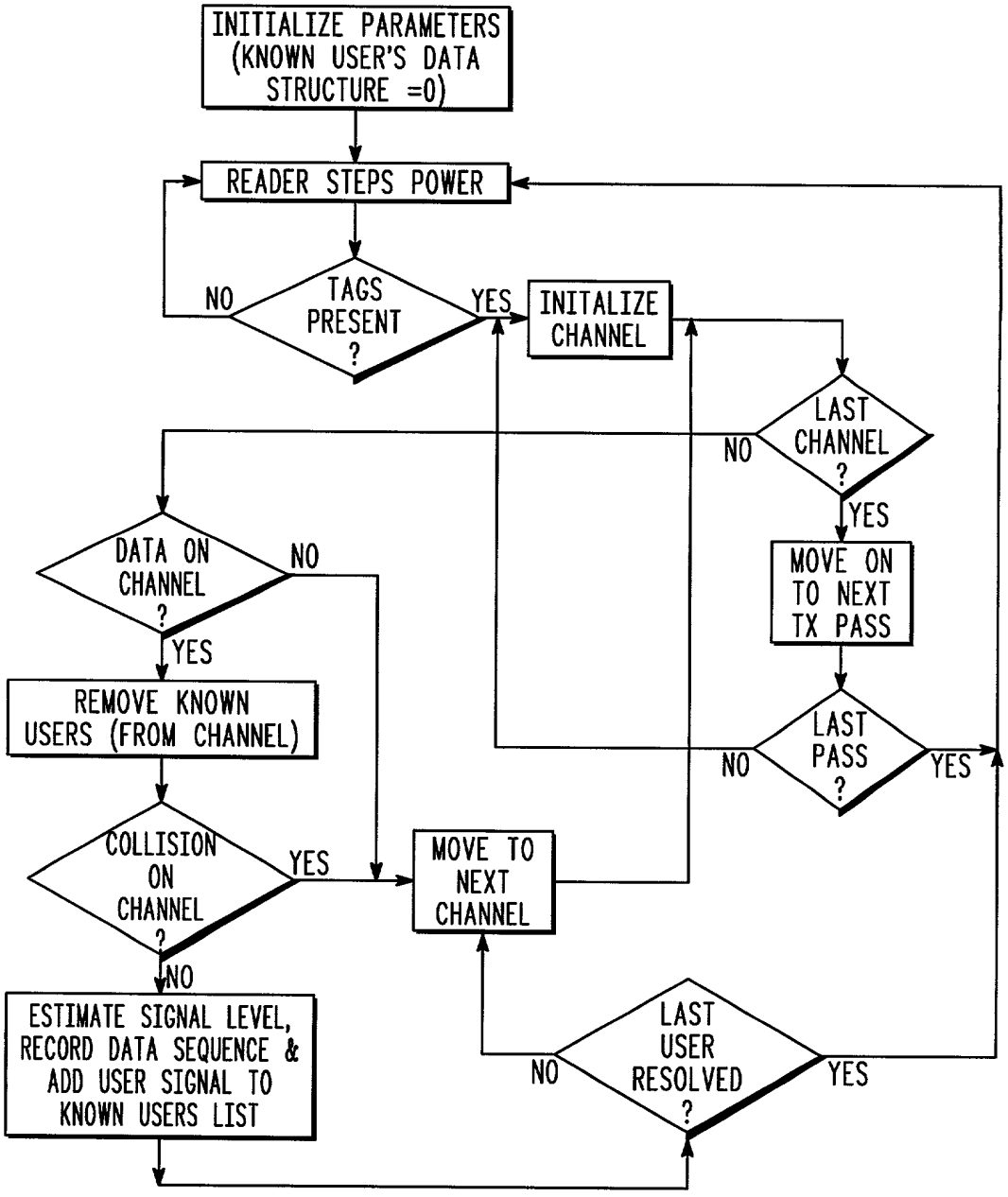

INITIALIZE PARAMETERS (KNOWN USER'S DATA STRUCTURE =0)
READER STEPS POWER
TAGS PRESENT ?
NO
YES
INITALIZE CHANNEL
LAST CHANNEL ?
NO
YES
DATA ON CHANNEL ?
NO
YES
MOVE ON TO NEXT TX PASS
REMOVE KNOWN USERS (FROM CHANNEL)
LAST PASS ?
NO
YES
COLLISION ON CHANNEL ?
YES
MOVE TO NEXT CHANNEL
NO
ESTIMATE SIGNAL LEVEL, RECORD DATA SEQUENCE & ADD USER SIGNAL TO KNOWN USERS LIST
LAST USER RESOLVED ?
NO
YES

FIG. 20

CHANNEL NUMBER	#0	#1	#2	#3	#4	#5	#6	#7
PASS #1	①	2 6	4 8		③	⑦	⑤	
PASS #2	1 4 5	2 8			6 7			3
PASS #3	②			1 8	4 7		3	5 6
PASS #4			5	7	④	⑧	1 2 6	3
PASS #5	1		2	5 7	3	6 8	4	
PASS #6		4 8		5	1 3 6	2	7	
PASS #7		3 4 8		1 6		2 5		7
PASS #8		2 4	⑥			5 7 8	1 3	

LEGEND: CIRCLED ITEMS ARE NEWLY ID'd
SHADED ITEMS ARE PREVIOUSLY ID'd

FIG. 21

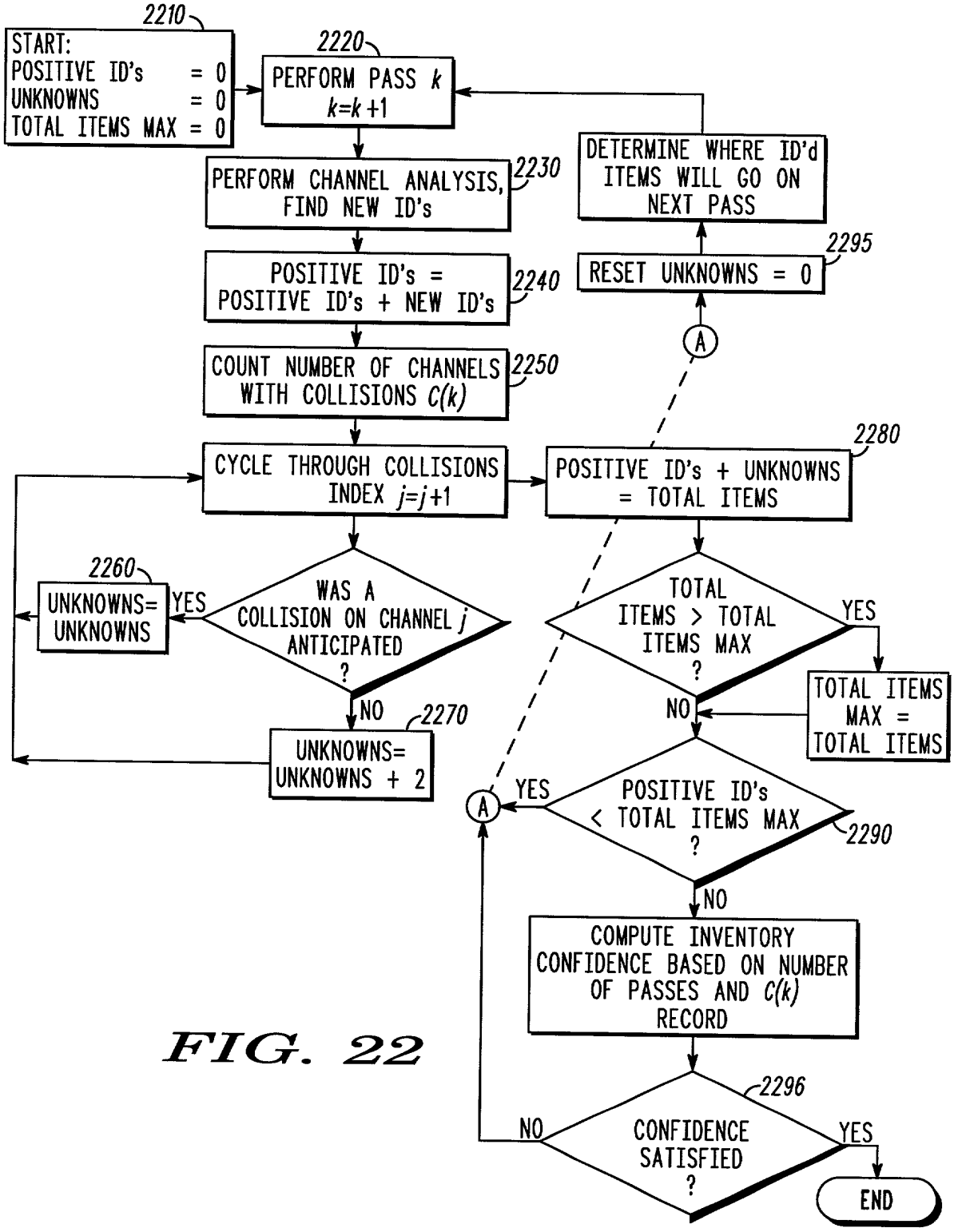

2210
START:
POSITIVE ID's = 0
UNKNOWNS = 0
TOTAL ITEMS MAX = 0
2220
PERFORM PASS k
k=k+1
PERFORM CHANNEL ANALYSIS, FIND NEW ID's
2230
POSITIVE ID's = POSITIVE ID's + NEW ID's
2240
COUNT NUMBER OF CHANNELS WITH COLLISIONS C(k)
2250
CYCLE THROUGH COLLISIONS INDEX j=j+1
WAS A COLLISION ON CHANNEL j ANTICIPATED ?
YES
2260
UNKNOWNS= UNKNOWNS
NO
2270
UNKNOWNS= UNKNOWNS + 2
DETERMINE WHERE ID'd ITEMS WILL GO ON NEXT PASS
2295
RESET UNKNOWNS = 0
A
2280
POSITIVE ID's + UNKNOWNS = TOTAL ITEMS
TOTAL ITEMS > TOTAL ITEMS MAX ?
YES
TOTAL ITEMS MAX = TOTAL ITEMS
NO
A
YES
POSITIVE ID's < TOTAL ITEMS MAX ?
2290
NO
COMPUTE INVENTORY CONFIDENCE BASED ON NUMBER OF PASSES AND C(k) RECORD
2296
CONFIDENCE SATISFIED ?
NO
YES
END

FIG. 22

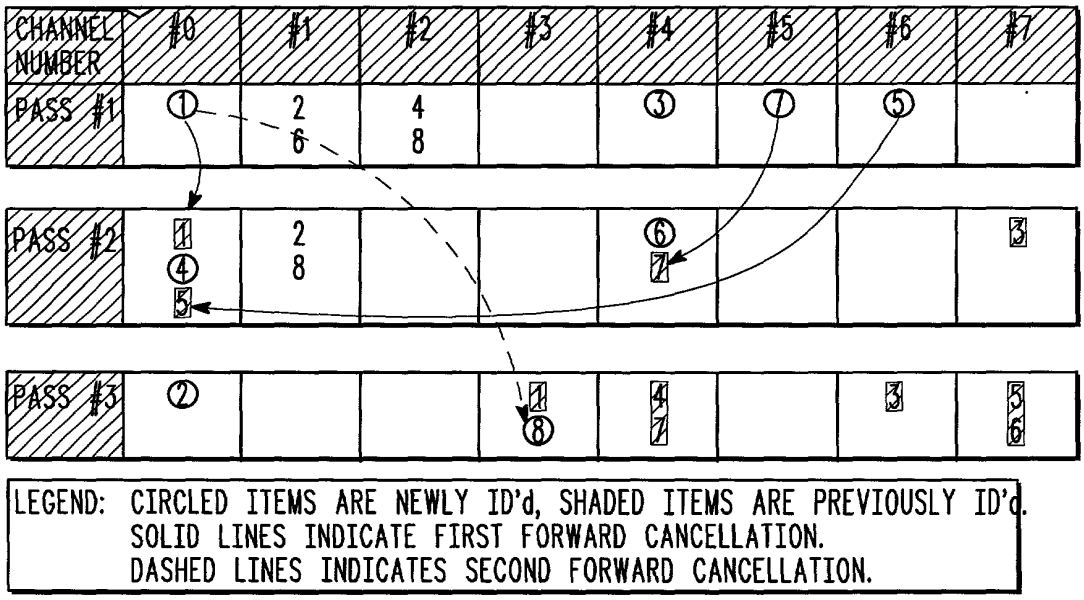

CHANNEL NUMBER
#0
#1
#2
#3
#4
#5
#6
#7
PASS #1
PASS #2
PASS #3
LEGEND: CIRCLED ITEMS ARE NEWLY ID'd, SHADED ITEMS ARE PREVIOUSLY ID'd.
SOLID LINES INDICATE FIRST FORWARD CANCELLATION.
DASHED LINES INDICATES SECOND FORWARD CANCELLATION.

FIG. 23

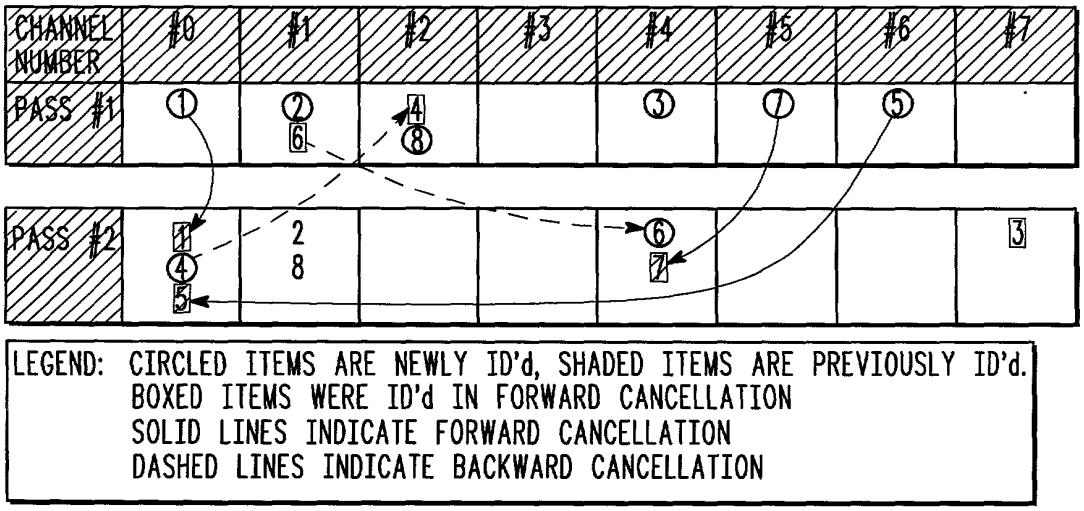

CHANNEL NUMBER
#0
#1
#2
#3
#4
#5
#6
#7
PASS #1
PASS #2
LEGEND: CIRCLED ITEMS ARE NEWLY ID'd, SHADED ITEMS ARE PREVIOUSLY ID'd.
BOXED ITEMS WERE ID'd IN FORWARD CANCELLATION
SOLID LINES INDICATE FORWARD CANCELLATION
DASHED LINES INDICATE BACKWARD CANCELLATION

FIG. 24